Designing Workforce Management Systems for Industry 4.0

Data-Centric and AI-Enabled Approaches

Edited by
Alex Khang
Sita Rani
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Designing Workforce Management Systems for Industry 4.0

This book brings insight to the Human Resource (HR) management system and offers data-centric approaches and AI-enabled applications for the design and implementation strategies used for workforce development and management.

Designing Workforce Management Systems for Industry 4.0: Data-Centric and AI-Enabled Approaches focuses on the mechanisms of proposing solutions along with architectural concepts, design principles, smart solutions, and intelligent predictions with visualization simulation. Data visualization for the metrics of management systems and robotic process automation applications and tools are also offered.

This book is also useful as a reference for those involved in AI-enabled applications, data analytics, data visualization, as well as systems engineering and systems designing.

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Contents

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List of Figures and Tables

Preface

In the era of the Fourth Industrial Revolution, we observe several powerful data-centric approaches, Internet of Things (IoT) technologies, cloud-based services, artificial intelligence (AI) science, machine learning (ML) models, deep learning (DL) frameworks, and data analytics used to support human capital management systems. Therefore, people are eager to leverage the most multifaceted data-centric approaches, AI-enabled applications, and emerging technologies to develop, deploy, and deliver next-generation workforce management systems (WMS).

Nowadays, resource-intensive competency models, methodologies, principles, tools, software, and networks are spreading across a variety of platforms and extensive supporting with the power of AI science and Data engineering. More precisely, the convergence of data-centric approaches, AI-enabled applications, and modern competency models are being touted as a conflux of next-generation solutions to design and implement a more flexible, and smarter human capital management system in order to deliver all kinds of connected as well as more intelligent services for all business operations.

Despite there are particular challenges associated with the adoption of data-centric approaches and AI-enabled applications in the complex operations of the WMS, and if they are integrated with full functionality to support the decision-making process, then we need these models and processes to articulate how they arrive at and process these decisions, as any wrong decision may result in irreparable damage. Hence, the trust and transparency of data-centric AI solutions are being seen as a critical challenge. Managers and business owners must insist on the unambiguous interpretability and explain the exact ability of AI-enabled systems' decisions. This is how the new disciplines of AI technology has flourished and is being recommended as a viable approach for overcoming this trust issue in workforce development and management.

The book brings insight into the WMS and offers data-centric approaches and AI-enabled applications for implementing the strategies of workforce development and management. It includes current developments, future directions, and also covers the concept of human capital management systems along with their sub-systems. It presents the insights of job performance analysis, building an efficient workforce, employee trainings, and many other concepts. It also focuses on the mechanisms of proposing solutions along with architectural concepts, design principles, smart solutions, and intelligent predictions with visualization simulation for the modern WMS.

The 20 chapters of this book are useful to researchers involved in AI-enabled applications, data analytics, and data visualization in the modern WMS. The book is also suitable as supporting material for undergraduate and graduate-level courses in related business administration disciplines.

Happy reading!

Alex Khang, Sita Rani, Rashmi Gujrati,
Hayri Uygun, and Shashi Kant Gupta

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This book is based on the concepts and design of data-centric, AI-enabled workforce management systems for the Industry 4.0 ecosystem. The idea to present a book to the readers in this domain was the brainchild of the editorial team. But it was not possible to bring it to reality without the hard work and trust of worthy contributors. Their effort and experience are rewarding for the academic world. So we especially want to acknowledge every individual who contributed to making this idea a success.

To all the reviewers we have had the opportunity to collaborate with and watch their hard work from afar, we acknowledge their tremendous support and valuable comments. Their support will also play a big role in the inspiration and foundation for future projects.

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And last but not least, we are grateful to our publisher, CRC Press (Taylor & Francis Group), for the wonderful support ensuring the timely processing of the manuscript and bringing this book to the readers.

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1 Workforce Management System

Concepts, Definitions, Principles, and Implementation

Snehal Maheshkar, Babasaheb Jadhav, and Alex Khang

CONTENTS

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1.1 INTRODUCTION

In the twenty-first century, change is happening more quickly. There is strong competition for the best talent in the corporate world. The abilities that employers are searching for in their employees are changing as a result of automation and machines replacing human work.

One of a business's most valuable resources for success is its personnel. To achieve efficiency and profitability, businesses must employ the proper amount of staff members with the appropriate skills and duties.

There are numerous workforce management advisors, consultants, and solution providers who manage all the tasks required to keep a creative staff, signaling the beginning of innovation in the workforce with the help of AI. Understanding the workforce separately and collectively is essential for comprehending the workforce through automation.

1.2 RELATED WORK

1.2.1 Industry 4.0

The rising technologies shown in Figure 1.1 are the foundation of Industry 4.0, or smart manufacturing, which has new demands on the manufacturing workforce in the age of AI and automation. The continued advancement of technology will enable machines and computers to eventually do tasks better than people (Bonekamp & Sure, 2015).

1.2.2 Workforce

According to Oxford Dictionary, "the definition of *workforce* is any individual who is actively seeking employment or who is available to do so in a certain region, company, or industry." The labor group employed by a business is known as the workforce. It is the labor market in the workplace.

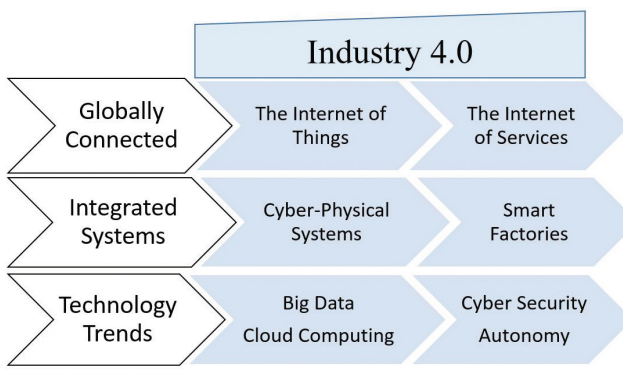

FIGURE 1.1 The foundation of Industry 4.0. (*Source*: Flynn, Dance, & Schaefer, 2017.)

The term *global workforce* refers to the international labor pool of workers, which may include immigrant workers, transient migrant workers, telecommuters, those in export-oriented employment, contingent workers, or other precarious employment, as well as those employed by multinational corporations, who are linked through a global system of networking and production.

A workforce is defined in the context of an organization as a collection of knowledge, experience, and abilities that people possess and apply to create value for the company (Agolla, 2018).

Industry 4.0 provides an opportunity to reinvent jobs and pay more attention to employees' skill development. The holistic method for managing human resources (HR) for Industry 4.0 lists four required employee competencies: technical, methodological, social, and personal (Khang et al., 2023).

Human capital will remain the key processor and decision-maker, which requires higher cognitive demands and mental tasks to control the developments that evolved from mechanization to computerization (Rana et al., 2021).

1.2.3 Types of Workforce

Employers may have as many as six or seven kinds of workers on board at any given moment in a labor market that has grown more complex. Seasonal and contingent workers work alongside full-time, part-time, and temporary employees. Here are different employee classifications employers may encounter.

- Full-time.
- Part-time.
- Temporary.
- Seasonal.
- Independent contractors.
- Freelancers.
- Temporary workers.
- Consultants.

1.2.4 Workforce Diversity

Due to growing globalization, interactions between people of different origins are necessary. People no longer live and work in isolated communities. The traditional workplace is evolving along with general workplace trends like more automation and digital technology, flexible working, and a desire for businesses to have a social purpose.

Corporations must prioritize utilizing and capitalizing on workplace diversity. *Workforce diversity* refers to policies and practices that aim to incorporate individuals within a workforce who are thought to be, in some manner, distinct from those in the dominant constituency.

Workforce diversity is the collective mixture of employees' differences and similarities, which includes characteristics, values, beliefs, experiences, backgrounds, preferences, and behaviors.

1.2.5 Benefits of Workforce Diversity

More than ever, the human resources (HR) industry is thriving in terms of workplace diversity. People from all walks of life are employed by a diverse workforce. These are workers who will have various perspectives on the world and who will use their situations and experiences to offer fresh ideas that will help businesses to top the success iceberg. Researchers have listed a few concrete benefits of workplace diversity as Figure 1.2.

The achievement of organizational goals, improved efficiency, better decision-making, growth, and development within an organization all depend on workplace diversity management and AI technologies. Workforce diversity management is an individual difference that can be visible (based on color, ethnicity, age, gender, physical ability, etc.) or invisible (based on education, competencies and skills, motivation, work experience, etc.) (Khanh & Khang, 2021).

So far, industrial revolutions include coal, gas, electronics, nuclear power, renewable energy, internet technology, and automation. From 1760 to the present, there has been an astonishing evolution. The entire terrain of the modern world has undergone numerous changes as a result of the different energy sources and, later, technologies that were discovered. The four industrial revolutions are briefly described as follows Figure 1.3.

In Europe and North America, the First Industrial Revolution took place in the nineteenth century. During that time, rural, primarily agrarian communities transitioned to industrial, metropolitan societies. The agricultural community was impacted by the First Industrial Revolution.

The majority of the work was done manually. People who lost their farming livelihoods when factories occupied their former fields retrained to become boilermakers, ironsmiths, mechanics, etc. There was little demand for advanced skills (Bhambri et al., 2022).

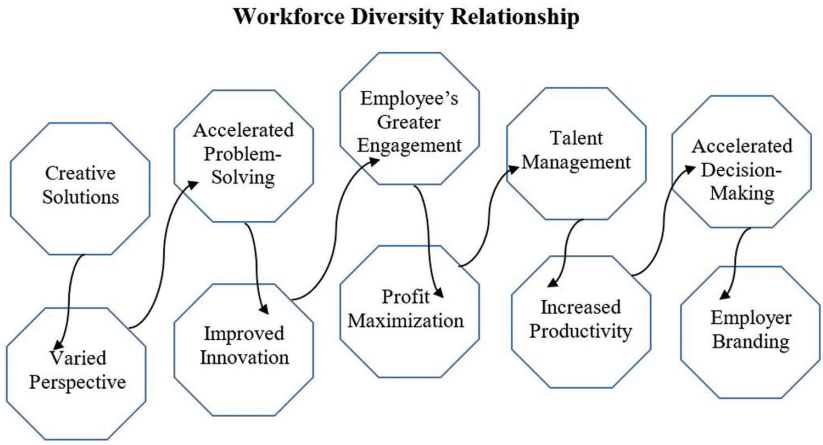

FIGURE 1.2 The thriving in terms of workplace diversity in the HR industry.

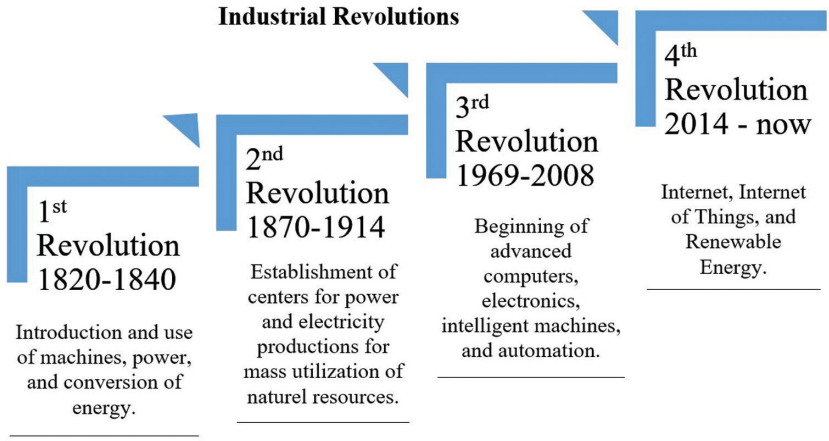

FIGURE 1.3 The four industrial revolutions.

The Second Industrial Revolution occurred just before World War I, between 1870 and 1914. It was a time of expansion for new industries as well as growth for those already established, including the mass manufacturing of steel, oil, and electricity.

The transition from analog electronic and mechanical equipment to digital technology is referred to as the Third Revolution, or Digital Revolution. The development of the PC, Internet, and ICT are examples of Third Industrial Revolution advancements. It was able to produce large quantities in tiny batches with a greater variety. Robots and computers have taken over many jobs (Hajimahmud et al., 2022).

High-speed internet, artificial intelligence, automation, big-data analytics, and cloud computing are four distinct technological advancements that are significantly responsible for the Fourth Industrial Revolution.

Looking at the current pace of innovation, Price Waterhouse and Coopers & Lybrand merge to create PricewaterhouseCoopers (PwC) believes that by 2030, the global workforce will be entirely different. It predicts that world employment could become one of four worlds: red, yellow, green, or blue as Figure 1.4.

1.2.5.1 The Red World Is All about Speed and Innovation

The Red World is a perfect incubator for innovation in organizations and individuals what they want. Organizations and business owners compete to conceptualize and possess concepts that satisfy the needs of consumers. The greatest resource is human intelligence, and success is correlated with the demanded talent.

Performance in this context is more concerned with the outcome than the process. The Red World won't have a distinct HR department. Entrepreneurial leaders will rely on automated human processes and outsourced services. Larger organizations will search the globe for talent by utilizing AI and specialized talent strategists to find the experts they need (Tailor et al., 2023).

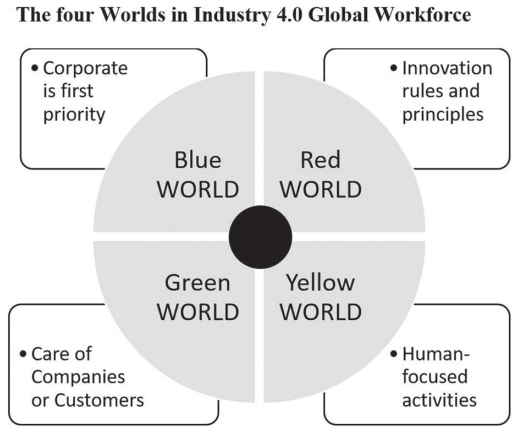

FIGURE 1.4 The four worlds in global workforce.

1.2.5.2 The Blue World Is All about Extreme Talent

The Blue World will be entirely talent-driven, which is essential for maintaining profit margins. Employees at all levels will strive to advance their professional growth and attempt to sharpen their skills through the use of cognition-enhancing methods, because talent will be so vital (Khang et al., 2022a,b).

1.2.5.3 The Green World Is All about the Company's Caring

The Green World is characterized by a strong social conscience, environmental responsibility, an emphasis on diversity and human rights, and a knowledge that business has repercussions beyond the bottom line.

1.2.5.4 The Yellow World Is All about Humans Coming First

Here, humans come first. Compared to its Red and Blue counterparts, the Yellow World of work places a considerably higher emphasis on individuals. Locally and socially conscious businesses are the most prosperous.

1.2.6 Building a Connected Workforce for Industry 4.0

It's natural to believe that Industry 4.0 will eliminate chances for human labor in services, factories, mines, ports, and other settings emphasizing automation, AI, and digitalization. In reality, today's occupations will change as Industry 4.0 technologies gain traction, and new job possibilities will be created by the new skills needed by the 4.0 workforce (Rani et al., 2021).

These new methods of working in the Fourth Industrial Revolution will result in workforces that are streamlined, nimble, and technology-augmented, making them safer, happier, healthier, and more suited to do their jobs, while boosting productivity for the corporations (Hahanov et al., 2022). This process may include the following.

1.2.6.1 Continue to Combat Knowledge Loss

The long-term threat to workforce management success may be knowledge erosion. Thus, it's crucial to include frequent ongoing training in your workforce management contract. Pay special attention to best practices and refresher modules that can assist in reskilling and upskilling.

1.2.6.2 Place a Priority on People, Processes, and Culture

There are so many powerful new capabilities that AI technology offers. But it is important not to be beguiled by technology at the expense of establishing a strong business foundation built on people, processes, and culture.

Ultimately, if the underlying processes don't change and the people and the culture of your organization are not ready for the technology, any automation and implementation will fail.

1.2.6.3 Strengthening the Employee Value Proposition

Employees get what in exchange for what they give to help retain talent in the most critical roles?

1.2.6.4 Rethinking the Talent Paradigm, Not Just Attracting and Retaining Employees

To create a more dynamic organization and place, you need focus on developing talent pipelines, upskilling current employees, and using shorter-term work arrangements.

1.2.6.5 Lead with Quality

It is imperative to identify and measure quality outcome indicators before, during, and after change implementation.

1.2.6.6 Set Direction with Comparative Benchmarking

Identify internal and external best performance practices and sustain continuous improvement through the process of benchmarking.

1.2.6.7 Elevate and Support through Coaching and Education

Technology is relatively easy to implement. The challenge is ensuring that the people who interact with the technology have the skills they need to get value out of it. Employees must not only be trained on how to operate new technology but on how to embed the technology in their daily work.

1.2.6.8 Conducting a Job Analysis to Understand How Work Is Currently Done

Use the data to determine how it could be done more efficiently in the age of AI.

1.3 CONCLUSION

The truth is that businesses need to start visualizing the future for themselves, because it is already here. The guidelines alter occasionally. What matters and how value is created in business are undergoing a fundamental upheaval. Talent has not

only taken the position of the land, capital, and raw materials as the main source of competitive advantage, but talent's objectives and expectations have also changed.

The exact design of workplaces in the future won't be determined solely by factors of technological and cultural growth. A change in how work is accomplished is also significant. The places where people work, the ways they communicate, and how business interactions and transactions are carried out and managed are all changing quickly (Hahanov et al., 2022).

Business executives should consider how they would respond if the world becomes more blue or green. Existing employees should consider their skill set rather than the position they currently hold. Even in near future, it will be impossible to forecast exactly what skills will be required. Therefore, people and organizations must be prepared to adapt to any of the futures we see.

A significant portion of advanced technical responsibilities will inevitably fall to the individual. In addition to being able to adapt to organizational change, they will need to be eager to learn new things throughout their lives, take on new responsibilities, and even rethink and retrain in the middle of their careers (Khang, Chowdhury, & Sharma, 2002).

This is of immense and vital importance to their workplace. In the age of AI technology, upskilling of the brownfield workforce by using hybrid strategies will support corporations in Industry 4.0 to achieve a level of greenfield workforce (Vrushank, Khang, & Rani, 2023). The framework proposed in this chapter will benefit researchers and corporations in overcoming the challenges and weaknesses of workforce management.

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